

CLAIMS

What is claimed is:

1. A magnetic stimulator for magnetically stimulating a region
5 of a body, comprising:

a first coil producing a first time-varying magnetic field
adjacent a brain of the body at a first frequency; and

a second coil producing a second time-varying magnetic field
adjacent the brain at a second frequency that is different than
10 the first frequency;

wherein the first and second coils are oriented such that
the first and second magnetic fields produce a beat frequency
time-varying electric field in the region of the body, the beat
frequency being determined by the first and second frequencies.

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2. The magnetic stimulator of claim 1, wherein the first
frequency is within about 100 Hz of the second frequency.

3. The magnetic stimulator of claim 1, wherein the first
20 frequency is within about 50 Hz of the second frequency.

4. The magnetic stimulator of claim 1, wherein the first and
second frequencies are each between about 5 KHz and about 100 KHz.

5. The magnetic stimulator of claim 1, wherein the beat
25 frequency is between about 1 Hz and about 100 Hz.

6. The magnetic stimulator of claim 1, wherein the beat
frequency is between about 10 Hz and about 50 Hz.

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7. The magnetic stimulator of claim 1, wherein the first coil
comprises a Hased coil, and the second coil comprises a Hased
coil.

8. The magnetic stimulator of claim 1, wherein the first coil comprises at least two coils, and the second coil comprises at least two coils.

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9. The magnetic stimulator of claim 8, wherein the first coil comprises a Helmholtz coil, and the second coil comprises a Helmholtz coil.

10 10. The magnetic stimulator of claim 8, wherein the at least two coils of the first coil are electrically connected to each other in series, and the at least two coils of the second coil are electrically connected to each other in series.

15 11. The magnetic stimulator of claim 8, wherein the at least two coils of the first coil are electrically connected to each other in parallel, and the at least two coils of the second coil are electrically connected to each other in parallel.

20 12. The magnetic stimulation of claim 1, wherein amplitudes of the first and second time-varying magnetic fields vary as respective sine functions.

13. The magnetic stimulator of claim 1, further comprising:
25 a first signal generator connected to the first coil; and
a second signal generator connected to the second coil.

14. The magnetic stimulator of claim 13, wherein:
the first signal generator produces a signal at the first
30 frequency; and
the second signal generator produces a signal at the second frequency.

15. The magnetic stimulator of claim 1, wherein the first coil comprises:

a first conductor defining a signal path to a point on the first conductor; and

5 at least one second conductor defining a signal path away from the point, the at least one second conductor being electrically connected in series with the first conductor at the point and extending from the point to a location spaced from the first conductor by a predetermined distance, at
10 least a portion of the at least one second conductor adjacent the point being non-parallel to the first conductor.

16. A magnetic stimulator for magnetically stimulating a region of a body, comprising:

a first coil producing a first time-varying magnetic field at a first frequency; and

a second coil producing a second time-varying magnetic field at a second frequency that is different than the first frequency,
20 the first frequency being within about 50Hz of the second frequency;

wherein the first and second coils are oriented such that the first and second magnetic fields produce a beat frequency time-varying electric field in the region of the body, the beat
25 frequency being determined by the first and second frequencies.

17. The magnetic stimulator of claim 16, wherein the first and second frequencies are each between about 5 KHz and about 100 KHz.

30 18. The magnetic stimulator of claim 16, wherein the beat frequency is between about 10 Hz and about 50 Hz.

19. The magnetic stimulator of claim 16, wherein the first coil comprises at least two coils, and the second coil comprises at least two coils.

5 20. The magnetic stimulator of claim 19, wherein the first coil comprises a Helmholtz coil, and the second coil comprises a Helmholtz coil.

10 21. The magnetic stimulator of claim 19, wherein the at least two coils of the first coil are electrically connected to each other in series, and the at least two coils of the second coil are electrically connected to each other in series.

15 22. The magnetic stimulator of claim 19, wherein the at least two coils of the first coil are electrically connected to each other in parallel, and the at least two coils of the second coil are electrically connected to each other in parallel.

20 23. The magnetic stimulation of claim 16, wherein amplitudes of the first and second time-varying magnetic fields vary as respective sine functions.

24. The magnetic stimulator of claim 16, further comprising:
a first signal generator connected to the first coil; and
25 a second signal generator connected to the second coil.

25. The magnetic stimulator of claim 24, wherein:
the first signal generator produces a signal at the first frequency; and
30 the second signal generator produces a signal at the second frequency.

26. The magnetic stimulator of claim 16, wherein the first coil comprises:

a first conductor defining a signal path to a point on the first conductor; and

5 at least one second conductor defining a signal path away from the point, the at least one second conductor being electrically connected in series with the first conductor at the point and extending from the point to a location spaced from the first conductor by a predetermined distance, at
10 least a portion of the at least one second conductor adjacent the point being non-parallel to the first conductor.

27. A magnetic stimulator for magnetically stimulating a region
15 of a body, comprising:

a first coil producing a first time-varying magnetic field at a first frequency; and

a second coil producing a second time-varying magnetic field at a second frequency that is different than the first frequency,
20 each of the first and second frequencies being between about 5 KHz and about 100 KHz;

wherein the first and second coils are oriented such that the first and second magnetic fields produce a beat frequency time-varying electric field in the region of the body, the beat
25 frequency being determined by the first and second frequencies.

28. The magnetic stimulator of claim 27, wherein the first frequency is within about 100 Hz of the second frequency.

30 29. The magnetic stimulator of claim 27, wherein the beat frequency is between about 1 Hz and about 100 Hz.

30. The magnetic stimulator of claim 27, wherein the beat frequency is between about 10 Hz and about 50 Hz.

31. The magnetic stimulator of claim 27, wherein the first coil comprises at least two coils, and the second coil comprises at least two coils.

32. The magnetic stimulator of claim 31, wherein the first coil comprises a Helmholtz coil, and the second coil comprises a Helmholtz coil.

33. The magnetic stimulator of claim 31, wherein the at least two coils of the first coil are electrically connected to each other in series, and the at least two coils of the second coil are electrically connected to each other in series.

34. The magnetic stimulator of claim 31, wherein the at least two coils of the first coil are electrically connected to each other in parallel, and the at least two coils of the second coil are electrically connected to each other in parallel.

35. The magnetic stimulation of claim 27, wherein amplitudes of the first and second time-varying magnetic fields vary as respective sine functions.

36. The magnetic stimulator of claim 27, further comprising:
a first signal generator connected to the first coil; and
a second signal generator connected to the second coil.

37. The magnetic stimulator of claim 36, wherein:
the first signal generator produces a signal at the first frequency; and

the second signal generator produces a signal at the second frequency.

38. The magnetic stimulator of claim 27, wherein the first coil
5 comprises:

a first conductor defining a signal path to a point on
the first conductor; and

at least one second conductor defining a signal path
away from the point, the at least one second conductor being
10 electrically connected in series with the first conductor at
the point and extending from the point to a location spaced
from the first conductor by a predetermined distance, at
least a portion of the at least one second conductor
adjacent the point being non-parallel to the first
15 conductor.

39. A magnetic stimulator for magnetically stimulating a region
of a body, comprising:

a first coil producing a first time-varying magnetic field
20 at a first frequency; and

a second coil producing a second time-varying magnetic field
at a second frequency that is different than the first frequency;

wherein the first and second coils are oriented such that
the first and second magnetic fields produce a beat frequency
25 time-varying magnetic field in the region of the body, the beat
frequency being between about 1 Hz and about 50 Hz and being
determined by the first and second frequencies.

40. The magnetic stimulator of claim 39, wherein the beat
30 frequency is between about 10 Hz and about 50 Hz.

41. The magnetic stimulator of claim 39, wherein the first and
second frequencies are each between about 5 KHz and about 100 KHz.

42. The magnetic stimulator of claim 39, wherein the first coil comprises at least two coils, and the second coil comprises at least two coils.

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43. The magnetic stimulator of claim 42, wherein the first coil comprises a Helmholtz coil, and the second coil comprises a Helmholtz coil.

10 44. The magnetic stimulator of claim 42, wherein the at least two coils of the first coil are electrically connected to each other in series, and the at least two coils of the second coil are electrically connected to each other in series.

15 45. The magnetic stimulator of claim 42, wherein the at least two coils of the first coil are electrically connected to each other in parallel, and the at least two coils of the second coil are electrically connected to each other in parallel.

20 46. The magnetic stimulation of claim 39, wherein amplitudes of the first and second time-varying magnetic fields vary as respective sine functions.

25 47. The magnetic stimulator of claim 39, further comprising:
a first signal generator connected to the first coil; and
a second signal generator connected to the second coil.

48. The magnetic stimulator of claim 47, wherein:
the first signal generator produces a signal at the first
30 frequency; and
the second signal generator produces a signal at the second frequency.

49. The magnetic stimulator of claim 39, wherein the first coil comprises:

a first conductor defining a signal path to a point on the first conductor; and

5 at least one second conductor defining a signal path away from the point, the at least one second conductor being electrically connected in series with the first conductor at the point and extending from the point to a location spaced from the first conductor by a predetermined distance, at
10 least a portion of the at least one second conductor adjacent the point being non-parallel to the first conductor.

50. A method of magnetically stimulating a region of a body,
15 comprising:

subjecting the region to a beat frequency electric field produced by first and second time-varying magnetic fields having respective first and second frequencies, the first frequency being different than the second frequency, the region being adjacent a
20 brain of the body.

51. The method of claim 50, further comprising:

using a first coil to generate the first time-varying magnetic field; and

25 using a second coil to generate the second time-varying magnetic field.

52. The method of claim 51, further comprising:

30 using a third coil to generate the first-time varying magnetic field; and

using a fourth coil to generate the second-time varying magnetic field.

53. The method of claim 51, wherein the first and second coils are Helmholtz coils.

54. The method of claim 50, wherein the region of the body is within the brain.

55. A method of magnetically stimulating a region of a body, comprising:

subjecting the region to a beat frequency electric field produced by first and second time-varying magnetic fields having respective first and second frequencies, the first frequency being within 50 Hz of the second frequency, the first frequency being different than the second frequency.

56. The method of claim 55, further comprising:

using a first coil to generate the first time-varying magnetic field; and

using a second coil to generate the second time-varying magnetic field

57. The method of claim 56, further comprising:

using a third coil to generate the first-time varying magnetic field; and

using a fourth coil to generate the second-time varying magnetic field.

58. The method of claim 56, wherein the first and second coils are Helmholtz coils.

59. The method of claim 55, wherein the region of the body is adjacent a brain.

60. The method of claim 59, wherein the region of the body is within the brain.

61. A method of magnetically stimulating a region of a body,
5 comprising:

subjecting the region to a beat frequency electric field produced by first and second time-varying magnetic fields having respective first and second frequencies, the first frequency being different than the second frequency, the first and second
10 frequencies each being between about 5 KHz and about 100 KHz.

62. The method of claim 61, further comprising:

using a first coil to generate the first time-varying magnetic field; and

15 using a second coil to generate the second time-varying magnetic field.

63. The method of claim 62, further comprising:

using a third coil to generate the first-time varying
20 magnetic field; and

using a fourth coil to generate the second-time varying magnetic field.

64. The method of claim 62, wherein the first and second coils
25 are Helmholtz coils.

65. The method of claim 62, wherein the region of the body is adjacent a brain.

30 66. The method of claim 65, wherein the region of the body is within the brain.

67. A method of magnetically stimulating a region of a body, comprising:

subjecting the region to a beat frequency electric field having a frequency between about 1 Hz and about 50 Hz and produced
5 by first and second time-varying magnetic fields having respective first and second frequencies, the first frequency being different than the second frequency.

68. The method of claim 67, further comprising:

10 using a first coil to generate the first time-varying magnetic field; and

using a second coil to generate the second time-varying magnetic field.

69. The method of claim 68, further comprising:

15 using a third coil to generate the first-time varying magnetic field; and

using a fourth coil to generate the second-time varying magnetic field.

20 70. The method of claim 68, wherein the first and second coils are Helmholtz coils.

71. The method of claim 67, wherein the region of the body is
25 adjacent a brain.

72. The method of claim 71, wherein the region of the body is within the brain.

30 73. A method of magnetically stimulating a region of a body, comprising:

generating a first time-varying magnetic field having a first frequency along a first direction oriented toward the region of the body; and

generating a second time-varying magnetic field having a second frequency along a second direction oriented toward the region of the body; wherein:

the first direction is different than the second direction;

the first frequency is different than the second frequency;

and

the first frequency being within about 50 Hz of the second frequency.

74. The method of claim 73, wherein the first and second frequencies are each between about 5 KHz and about 100 KHz.

75. The method of claim 73, wherein a difference between the first and second frequencies is between about 10 Hz and about 50 Hz.

76. The method of claim 73, wherein the region of the body is adjacent a brain of the body.

77. The method of claim 73, wherein the region of the body is in a brain of the body.

78. A magnetic stimulation coil, comprising:

a first conductor defining a signal path to a point on the first conductor;

at least one second conductor defining a signal path away from the point, the at least one second conductor being electrically connected in series with the first conductor at the point and extending from the point to a location spaced from the first conductor by a predetermined distance, at

least a portion of the at least one second conductor adjacent the point being non-parallel to the first conductor; and

a lead electrically connected to the second conductor.

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79. The magnetic stimulation coil of claim 78, wherein the first and second conductors form an angle between about 1° and about 90° at the point.

10 80. The magnetic stimulation coil of claim 78, wherein the first and second conductors form an angle between about 1° and about 45° at the point.

15 81. The magnetic stimulation coil of claim 78, wherein the first and second conductors form an angle between about 10° and about 20° at the point.

20 82. The magnetic stimulation coil of claim 78, wherein respective portions of the first and second conductors proximate the point are curved.

83. The magnetic stimulation coil of claim 78, wherein the at least one second conductor comprises six conductors.

25 84. The magnetic stimulation coil of claim 78, wherein the second conductor comprises a wire.

85. The magnetic stimulation coil of claim 78, wherein the second conductor comprises a surface.

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86. The magnetic stimulation coil of claim 78, wherein the second conductor comprises at least a portion of a cone-shaped surface.

87. The magnetic stimulation coil of claim 78, wherein the second conductor comprises at least a portion of an umbrella-shaped surface.

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88. The magnetic stimulation coil of claim 78, further comprising a signal generator connected to the second conductors via the lead.

10 89. The magnetic stimulation coil of claim 88, wherein the signal generator operates at a frequency between about 5 KHz and about 100 KHz.

15 90. The magnetic stimulation coil of claim 88, wherein the signal generator operates at a frequency between about 1 Hz and about 1000 Hz.

91. The magnetic stimulation coil of claim 78, wherein the first conductor is substantially straight.

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92. The magnetic stimulation coil of claim 78, wherein the first conductor comprises a helical coil.

93. The magnetic stimulation coil of claim 78, wherein:
25 the first conductor comprises a plurality of conductors;
the second conductor comprises a plurality of conductors;
and

each of at least some of the second conductors is electrically connected in series with a different one of the first
30 conductors.